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Uncertainty in a CCS project: What critical geophysical information do you need to mitigate financial failure?

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Summary

The initial site location for a Carbon Capture and Sequestration (CCS) project needs a clear and well-defined injection reservoir based on reliable and repeatable geological, geophysical, and engineering data. Without careful attention to these disciplines and the technical guidance they can provide, the CCS project is at a high risk of financial failure. Three project examples will illustrate the critical importance of acquiring geophysical data as part of a CCS project.

Background

Through the Alberta Energy Regulator (AER), the Alberta government has developed an approval process to ensure that the project proceeds safely and environmentally responsibly.

In late 2021 the Alberta government requested Expressions of Interest (EOI) from companies interested in developing and operating a carbon sequestration hub in Alberta. There were so many submissions with various project scenarios that the Government created the Request for Full Project Proposals (RFPP) process.

To keep the process manageable, the Government requested that the first round of RFPPs be located in the industrial heartland NE of Edmonton. Six RFPPs, in April 2022, were selected to begin exploring how to safely develop carbon storage hubs in that region. These six have entered into agreements to evaluate further the project's suitability for injecting and permanently storing CO2 and other emissions.

A second competitive round of RFPPs for the rest of the province was initiated in 2022. This resulted in 19 proposals approved in October 2022 to develop CCS hubs throughout Alberta.

The Alberta government is accepting additional RFPPs for a potential third round in 2023.

If you are one of the first 19 RFPPs or are considering submitting a proposal soon, you may wish to attend this paper.

Initial Project Stage

In their early stages, CCS projects are generally characterized based on four specific criteria

1. Where are the source(s) and daily volumes of CO2?
2. How is the CO2 going to be transported to the injection site?
3. What are the target injection horizon(s)?
4. Where will your CCS facility and injection well(s) be placed?

You can also think of this from the real estate point of view: “Location, location, location.”

What is the value of information (VOI) of the geoscience data?

The geology and geophysics disciplines provide the best technical guidance concerning criteria 3.

What are the characteristics of the target injection horizons?

1. How continuous is the injection reservoir?
2. What is the injection zone lithology and possible facies changes?
3. What is the structure and faulting history of the generalized area
4. How competent and continuous is the vertical seal or cap rock?
5. Is there a secondary cap rock? How competent and continuous is this secondary cap rock?
6. How deep is/are the injection horizon(s)?
7. How far from the Precambrian basement is the infection horizon?
8. Is there any history of induced seismicity in the project area?

Three scenarios of CCS projects

Scenario One: Acquire and bury a permanent, proprietary 3D survey near the injection well location

Aquistore, Estevan Saskatchewan

Operator: Petroleum Technology Research Centre (PTRC)

CCS Project story:

Source of CO2: Boundary Dam 3 Carbon Capture Facility (2 km away)

Injection horizon: Cambrian sands at 3400m Subsea, immediately above Precambrian basement

Geophysical Systems: 4D Seismic, plus various ISM and plume monitoring

3D shot near the source of C02

4D seismic plume monitoring indicated that the injection plume was not going as planned

3D seismic indicated an NS flexure west of the injection well that is impacting the plume

Takeaway:

Thoroughly evaluate 3D before selecting the injection well location to identify potential faults and permeability barriers.

Scenario Two: Acquire a proprietary 3D

Potential CCS site in North Dakota

Evaluator: Carbon Storage Assurance Facility Enterprise (CarbonSAFE) and the Energy & Environmental Research Center (EERC) North Dakota

CCS Project Story:

They were characterizing three sandstone layers about 1 to 2 miles below the surface to demonstrate their suitability to store CO2 permanently.

Modelled reservoir layers based on well control only and created the initial plume model

Modelled reservoir layers based on 3D seismic tied to well control

The new model indicated that the plume would rise to a structural high.

Takeaway:

Integrate the geology and geophysics in your early CCS project stages

The operator re-evaluated the situation and moved their proposed injection site.

Scenario Three: Acquire a trade 3D

Potential CCS Site in West Central Alberta

Operator: Undisclosed

CCS Project story:

The operator identified a general area for a CCS injection site

The operator acquired a large trade 3D.

The regional, local, and site structural style and fault interpretations were made

The 3D seismic data was tied to well control

Stratigraphic and facies changes were identified, mapped, and modelled

Seismic reservoir characterization, geology and reservoir engineering data were integrated

A reservoir characterization model for the injection horizon and offsetting horizons was created and evaluated for reservoir continuity, caprock integrity, structure, and injection plume migration

Takeaway:

The geology and geophysical data supported a quality CCS facility location

The facility was recommended to be built

Acquire 3D data as a minimum uncertainty mitigator

Conclusion

CCS projects are capitally intensive endeavours. If you do your homework, you will likely succeed financially. It is essential to acquire geophysical information, especially 3D data, during the site selection and reservoir characterization stages.

This geophysical information needs to be integrated with the geology, reservoir, production and drilling engineering data to help mitigate the technical side of the uncertainty risk of a CCS project.

Additionally, collaborating with the surface and sub-surface landmen and the company financial advisors will create a successful, profitable, and environmentally safe CCS project.